CCS Long Term Control Plan Update

Alternatives Evaluation: Ranking and Recommendation

City of Alexandria, Virginia
Department of Transportation and Environmental Services

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GREELEY AND HANSEN

Table of Contents

Table of Contents

List of Tables

List of Figures

List of Attachments

Executive Summary

The purpose of this memorandum is to summarize the relative scoring and ranking of the alternatives considered for the City's Long Term Control Plan Update (LTCPU). Following the relative scoring and ranking, a recommendation is provided for a shortlist of CSO Control Strategies for further development and evaluation, including project siting, feasibility of construction and refined project costs.

Technical memoranda were developed separately to facilitate the scoring and ranking of the following technology alternatives:

- Tunnels;
- Storage Tanks;
- CSO Disinfection;
- Sewer Separation; and
- Green Infrastructure.

Combinations of alternatives were compiled for ranking the overall CSO control strategy, which include CS0-002 and CSO-003/4 collectively. A copy of the scoring spreadsheets is provided in Attachment A. The results of the scoring and subsequent ranking of the top five (5) CSO Control Strategies are provided in Table ES-1.

Table ES-1
CSO Control Strategy Ranking

Rank	Strategy No.	CSO Control Strategy	Score
1	S-3	Separate Storage Tunnels for CSO 002 and CSOs 003/4 and Outfall Relocation for CSO 002 to the Potomac	3.98
2	S-7	Storage Tunnel for CSO 003/4 and Tank at CSO 002	3.97
3	S-1	Storage Tunnels for CSOs 002/3/4	3.86
4	S-4	Separate Storage Tanks at CSO 002 and CSO 003/4	3.76
5	S-8	Storage Tunnel for CSO 003/4 and Disinfection at CSO 002	3.69

The top five ranked alternatives all scored well due to their ability to store the CSO and then send it to Alexandria Renew Enterprises (AlexRenew) Water Resources Reclamation Facility (WRRF) for an exceptional level of treatment. The store and treat approach allows for high levels of CSO volume reduction and bacteria reduction. Additionally, the store and treat approach provides good opportunities for the removal of additional nitrogen, phosphorous, and sediment from the Chesapeake Bay water shed.

The recommended shortlist of alternatives is provided in Table ES-2.

Table ES-2
Recommended Shortlist of Primary CSO Control Strategies

Strategy No.	CSO Control Strategy	Combination of Technology Alternatives	Outfall Location
S-3	Separate Storage Tunnels CSO-002 and CSO-003/4 and Outfall Relocation for CSO-002 to the Potomac	T1-A	Hooffs Run
		T4-A	Potomac River
S-7	Storage Tunnel for 003/4 and Storage Tank at 002	T1-A	Hooffs Run
		ST002-A	Hunting Creek Embayment
S-1	One Storage Tunnel for CSO-002/3/4	T2-A	Hooffs Run

Additionally, it is recommended the City continue to consider and evaluate green infrastructure, sewer separation, regulator modifications, and real time control as complementary CSO Control Strategies.

Section 1 Introduction

1.1 Alternatives Evaluation and Technical Memoranda

Technical memoranda were developed to facilitate the scoring and ranking of the following technology alternatives:

- Tunnels;
- Storage Tanks;
- CSO Disinfection;
- Sewer Separation; and
- Green Infrastructure.

These alternatives are briefly described in the following sections, with more details available in the individual technical memoranda.

1.2 Tunnels

The basic tunnel alternatives considered for the City's Long Term Control Plan Update (LTCPU) are described in detail in the *Alternatives Evaluation: Tunnels Technical Memorandum* and summarized in Table 1-1. Tunnels that provide both storage and outfall relocation are considered.

Table 1-1
Tunnel Alternatives

Technology Alternative	Name	Description
T1	Store and relocate CSO-003 and CSO-004 to AlexRenew	Divert flow from CSO-003 and CSO-004 into a tunnel that stores CSO flow and relocates excess CSO to a single pumped overflow at AlexRenew (CSO-002 addressed by other means).
T2	Store and relocate CSO-002, CSO-003, and CSO-004 to AlexRenew	Divert flow from CSO-002, CSO-003, and CSO-004 into a tunnel that stores CSO flow and relocates excess CSO to a single pumped overflow at AlexRenew. The current CSO-002 and CSO-003 overflow structure will remain as a relief for extreme wet weather events.
T3	Store and relocate CSO-002, CSO-003, and CSO-004 to the Potomac River	Storage tunnel capturing CSO-002, CSO-003, and CSO-004 for storage. Any CSO volume in excess of the tunnel will flow to the Potomac River north of the Wilson Bridge. CSO 002 and CSO-003 are maintained for extreme wet weather events.
T4	Store and relocate CSO-003 and CSO-004 to AlexRenew and relocate CSO-002 to the Potomac River	Two tunnels, one relocating CSO-003 and CSO-004 to AlexRenew (Alternative T1) and a second separate tunnel capturing CSO-002 only and conveying CSO-002 flow to the Potomac River north of the Wilson Bridge. CSO 002 is maintained for extreme events.

1.2.1 Alternative T1 – Tunnel Storage for CSO-003 and CSO-004 and Relocate CSO-004 to AlexRenew

Alternative T1 captures all flow from the current CSO-003 and CSO-004 and diverts those flows into a tunnel that stores and conveys the flow to the AlexRenew WRRF. Flows stored by the tunnel are pumped once the rain event has passed to the WRRF for treatment by a dewatering pump station. If the volume of flow from CSO-003 and CSO-004 is in excess of the storage capacity of the tunnel and/or treatment at the WRRF, excess flow is pumped by the Wet Weather Pump Station (WWPS) to a relocated outfall at the WRRF. Alternative T1 includes a tunnel that extends from the intersection of Duke Street and Daingerfield Road to the AlexRenew WRRF. An 8-ft diameter, 2,600-ft tunnel is the basis of the evaluation.

1.2.2 Alternative T2 – Tunnel Storage for CSO-002, CSO-003, and CSO-004 and Relocate CSO-004 to AlexRenew

As with Alternative T1, tunnel Alternative T2 captures all flow from CSO-003 and CSO-004 to be stored in the tunnel and conveyed to AlexRenew for treatment. In addition under Alternative T2, flows from CSO-002, up to the design volume, are also captured and conveyed to AlexRenew. Overflow volumes in excess of the storage capacity and/or treatment are pumped by the WWPS to a relocated outfall. Alternative T2 includes the tunnel as described in section 1.2.1 that extends from Duke Street to the AlexRenew WRRF. Additionally, the tunnel continues from AlexRenew to the vicinity of CSO-002 where it intercepts overflows. The proposed length of the CSO-003/004 tunnel plus the length of the CSO-002 tunnel is approximately 7,400-LF. An 8-ft diameter tunnel is the basis of the evaluation.

1.2.3 Alternative T3 – Combine CSO-002, CSO-003, and CSO-004 and Relocate to the Potomac River

Alternative T3 is identical to Alternative T2 with one modification: instead of the WWPS pumping excess volume at AlexRenew into Hooffs Run, the tunnel is extended due east to the Potomac River where the WWPS pumps excess flow into the Potomac River. This alternative still stores the same volume of CSO as Alternative T2, however any flow in excess of the tunnel capacity overflows to the Potomac River instead of Hooffs Run and results improved water quality in Hooffs Run and Hunting Creek.

1.2.4 Alternative T4 – Relocate CSO-002 to the Potomac River

Alternative T4 addresses CSO-002 by constructing a tunnel to store the overflows and during large wet weather events; flow in excess of the tunnel volume will overflow by gravity to a relocated outfall into the Potomac River. Under Alternative T4, CSO-003 and CSO-004 are addressed by other means. Alternative T4 includes a tunnel that extends from the intersection of Green Street and Royal Street to the Potomac River. A 15-ft diameter, 1,700-ft tunnel is the basis of this evaluation.

1.3 Storage Tanks

1.3.1 Alternative ST002-A

Alternative ST002-A is a 2.0 MG below grade storage tank that stores overflow from CSO-002. The size of the tank is manageable and there are locations available close to the outfall for the installation of the tank. The alternative includes a dewatering pump station, screening, and odor control.

1.3.2 Alternative ST003/4-A

Alternative ST003/4-A is a 0.8 MG below grade storage tank that stores overflow from CSO-003 and CSO-004. Locations for storage at CSO-003 and CSO-004 are very limited and construction will be challenging. The alternative includes a dewatering pump station, screening, and odor control.

1.4 Disinfection

1.4.1 Alternative D002-A

Alternative D002-A is a 120,000 gallon below grade chlorine contact tank that will capture and disinfect overflows from CSO-002. The size of the tank and facilities are manageable and there are locations available close to the outfall. The alternative includes chemical pumping and storage for sodium hypochlorite and bisulfite, a building, screening, and associated appurtenances.

1.4.2 Alternative ST003/4-A

Alternative D003/4-A is an 80,000 gallon below grade chlorine contact tank that will capture and disinfect overflows from CSO-003 and CSO-004. Locations for disinfection facilities at CSO-003 and

CSO-004 are very limited and construction will be challenging. The storage of chemicals in the highly urbanized area will also be challenging. The alternative includes chemical pumping and storage for sodium hypochlorite and bisulfite, a building, screening, and associated appurtenances.

1.5 Sewer Separation

1.5.1 Alternative SE002-Royal

Alternative SE002-Royal is separating 195 acres in the Royal Street Combined Sewer Area. The strategy for separation in the Royal Street area is separating the sanitary flow from the combined sewer wherever possible. With this approach the combined sewer lines are converted to storm sewers. However, until all separation is completed, the bypass structure must remain and CSO volumes will not be noticeably reduced. Sanitary sewage that is diverted into a separate sanitary sewer will reduce the bacteria concentration of CSO discharges until separation is fully complete, at which time the CSO outfall will be converted to a storm outfall.

1.5.2 Alternative SE003/4-King and West

Alternative SE003/4-King and West is separation of 91 acres in the King and West Combined Sewer Area. The overall strategy for separating the King and West area is to divert all sanitary flow to the Potomac Yard Trunk Sewer. In diverting sanitary sewage to the Potomac Yard Trunk Sewer, the existing combined trunk line is converted into a pure storm sewer. However, until all separation is completed, the bypass structure must remain and CSO volumes will not be noticeably reduced. Sanitary sewage that is diverted from the combined sewer into the Potomac Yard Trunk Sewer will reduce the bacteria concentration of CSO discharges until the separation is fully complete, at which time the CSO outfall will be converted to a storm outfall.

1.6 Green Infrastructure (GI)

1.6.1 Alternative GI002-Royal

Alternative GI002-Royal is targeting the treatment of runoff from approximately 1 acre of impervious cover with GI for City-owned parcels in the Royal Street Combined Sewer Area. Additionally, the alternative is targeting approximately 6.5 acres in the City-owned right-of-way in the area. If fully implemented an estimated 39% reduction in CSO volume could be achieved in the area.

1.6.2 Alternative GI003/4-King and West

Alternative GI003/4-King and West is targeting the treatment of runoff from approximately 0.8 acres of impervious cover with GI for City-owned parcels in the King and West Combined Sewer Area. Additionally, the alternative is targeting approximately 4 acres in the City-owned right-of-way in the area. If fully implemented an estimated 56% reduction in CSO volume could be achieved in the area.

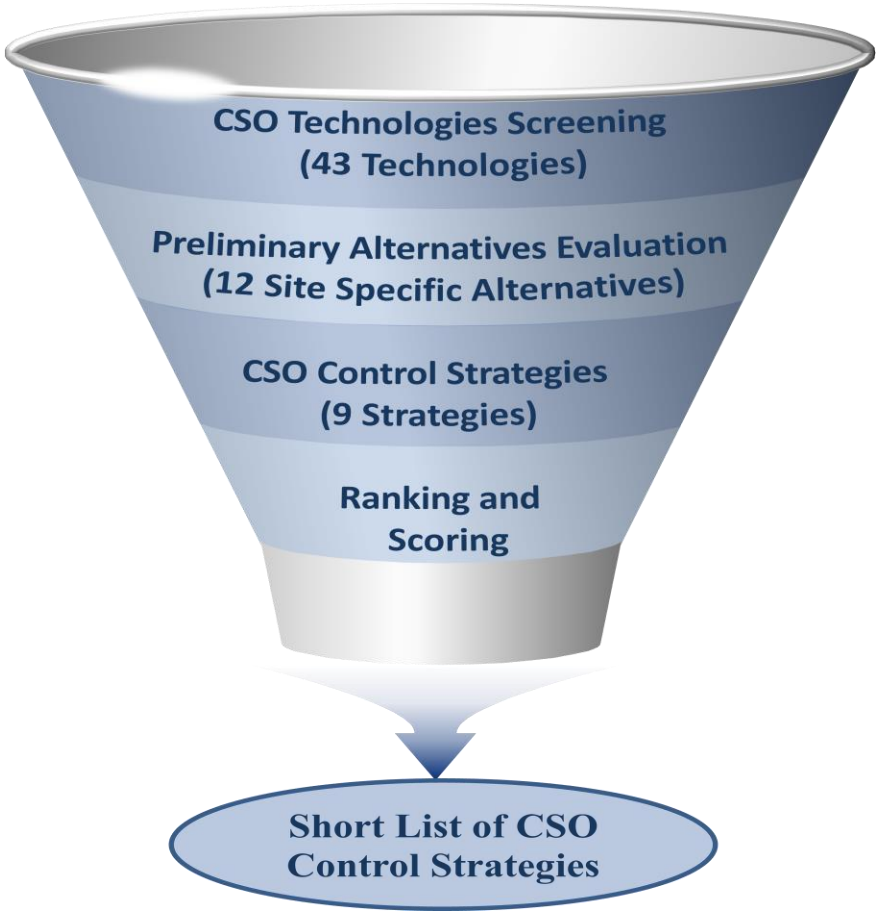
Section 2 CSO Control Strategies

The technologies developed in the alternatives technical memoranda, and summarized in Section 1, were maintained as standalone technologies or combined with other technologies for evaluating an overall CSO Control Strategy, which includes CS0-002 and CSO-003/4 collectively. The CSO Control Strategies are presented in Table 2-1. Figure 2-1 provides an overview of the shortlist process.

Table 2-1
Summary of CSO Control Strategies

Strategy No.	CSO Control Strategy	Combination of Technology Alternatives	Outfall Location
S-1	One Storage Tunnel for CSO-002/3/4	T2-A	Hooffs Run
S-2	One Storage Tunnel CSO-002/3/4 and Outfall Relocation to the Potomac	T3-A	Potomac River
S-3	Separate Storage Tunnels CSO-002 and CSO-003/4 and Outfall Relocation for CSO-002 to the Potomac	T1-A	Hooffs Run
		T4-A	Potomac River
S-4	Separate Storage Tanks at CSO 002 and CSO 003/4	ST003/4-A	Hooffs Run
		ST002-A	Hunting Creek Embayment
S-5	All Disinfection	D003/4-A	Hooffs Run
		D002-A	Hunting Creek Embayment
S-6	All Separation	SE003-King&West	N/A
		SE002-Royal	N/A
S-7	Storage Tunnel for CSO-003/4 and Storage Tank at CSO-002	T1-A	Hooffs Run
		ST002-A	Hunting Creek Embayment
S-8	Storage Tunnel for CSO-003/4 and Disinfection at CSO-002	T1-A	Hooffs Run
		D002-A	Hunting Creek Embayment
S-9	All Green Infrastructure	GI003/4-King&West	Hooffs Run
		GI002-Royal	Hunting Creek Embayment

Figure 2-1
LTCPU Shortlist Process



Section 3 Scoring and Ranking

3.1 Scoring and Ranking Approach

In the individual alternatives memoranda, each technology was evaluated based criterion defined in the *Evaluation Criteria Technical Memorandum*, which are summarized in Table 3-1. The criterion rankings of the individual technology alternatives were converted to a numeric score. A weighting was then applied to the numeric score for each criterion and then summed to determine an overall score for CSO-002 and then for CSO-003/4.

Table 3-1
Evaluation Criteria and Weighting Values

Evaluation Criteria	Weighting
Cost	40%
CSO Reduction	10%
Effectiveness	15%
Implementation	5%
Impact to the Community	10%
Expandability	2.5%
Net Environmental Benefit	5%
Nutrient Credits for the Chesapeake Bay TMDL	5%
Permitting Issues	2.5%
Required Maintenance	5%

Once each alternative was scored, combinations of alternatives were compiled for ranking the overall CSO control strategy, which includes CS0-002 and CSO-003/4 collectively. A copy of the scoring spreadsheets is provided in Attachment A. The results of the scoring and subsequent ranking of the CSO Control Strategies are provided in Table 3-2.

Table 3-2
CSO Control Strategy Ranking

Rank	Strategy No.	CSO Control Strategy	Score
1	S-3	Separate Storage Tunnels for CSO 002 and CSOs 003/4 and Outfall Relocation for CSO 002 to the Potomac	3.98
2	S-7	Storage Tunnel for CSO 003/4 and Tank at CSO 002	3.97
3	S-1	Storage Tunnels for CSOs 002/3/4	3.86
4	S-4	Separate Storage Tanks at CSO 002 and CSO 003/4	3.76
5	S-8	Storage Tunnel for CSO 003/4 and Disinfection at CSO 002	3.69
6	S-2	Storage Tunnels for CSOs 002/3/4 and Outfall Relocation to the Potomac	3.68
7	S-5	All Disinfection	3.34
8	S-9	All Green Infrastructure	3.23
9	S-6	All Separation	2.10

3.2 Scoring and Ranking Observations

Overall, the scoring between the alternates was relatively close. There is only 0.22 points separating the 4th ranked alternative from the 1st ranked alternative.

The top four ranked alternatives all scored well due to their ability to store the CSO and then send it to AlexRenew WRRF for an exceptional level of treatment. The store and treat approach allows for high levels of CSO volume reduction and bacteria reduction. Additionally, the store and treat approach provides good opportunities for the removal of additional nitrogen, phosphorous and sediment from the Chesapeake Bay watershed.

The top two ranked alternatives, as well as the forth rank alternative, propose strategies that provide separate infrastructure solutions for CSO-002 and CSO-003/4 rather than combined infrastructure joining the two into a single outfall.

There is a project currently under consideration by the City, AlexRenew, and Fairfax County, but independent of the LTPCU, to provide wet weather improvements including reduction of sanitary sewer overflows (SSOs), address basement backups during large wet weather events, as well combined sewer benefits. The project under consideration includes a 6-foot storage tunnel from CSO-004 to AlexRenew, a diversion structure, and a wet weather pumping station. The top three ranked CSO Control Strategies for the LTCPU all include a tunnel from CSO-003/4 to the AlexRenew WRRF; however, it is upsized to capture addition combined sewage from CSO-003.

The fourth ranked CSO control strategy, S-4 Separate Storage Tanks, scores well, but there is concern regarding the ability to construct a storage tank in the very urbanized area around CSOs 003 and 004. The sixth ranked CSO control strategy (S-2) adds considerable cost due to the longer tunnel without an equivalent increase in value in terms of CSO reduction and bacteria reduction.

Separation (S-6) scored the lowest primarily due to its high cost, negative impact on the community, and lack of nutrient credits. Disinfection, as a standalone technology (S-5), or in combination with a tunnel (S-8), scored poorly due to lack of CSO volume reduction, negative impact on the community, and lack of nutrient credits. Green infrastructure (S-9) received a low score; however, should not be considered as a primary control strategy as it falls well short of achieving the bacteria reduction required by the TMDL. However, both sewer separation and green infrastructure could be utilized as a complementary strategy in combination with the storage tanks and tunnel storage alternatives.

Section 4 Recommendation

4.1 Short List of Alternatives

The recommended shortlist of alternatives for further evaluation as part of the LTCPU is provided in Table 4-1.

Table 4-1
Recommended Shortlist of Primary CSO Control Strategies

Strategy No.	CSO Control Strategy	Combination of Technology Alternatives	Outfall Location
S-3	Separate Storage Tunnels CSO-002 and CSO-003/4 and Outfall Relocation for CSO-002 to the Potomac	T1-A	Hooffs Run
		T4-A	Potomac River
S-7	Storage Tunnel for 003/4 and Storage Tank at 002	T1-A	Hooffs Run
		ST002-A	Hunting Creek Embayment
S-1	One Storage Tunnel for CSO-002/3/4	T2-A	Hooffs Run

Parsed a different way, the shortlist of CSO Control Strategies can be presented as specific projects to consider:

- Storage tunnel from CSO-003/4 to AlexRenew WRRF, with stored flow pumped to the AlexRenew WRRF and remaining overflows at Hooffs Run;
- Storage tunnel from CSO-002 to the Potomac River, with stored flow pump to the AlexRenew WRRF and remaining overflows at the Potomac River;
- Storage tank at CSO-002 with stored flow pump to the AlexRenew WRRF and remaining overflows at the Hunting Creek Embayment; and
- Storage tunnel from CSO-002 and CSO-003/4 connecting and terminating at the AlexRenew WRRF, with stored flow pumped to the AlexRenew WRRF and remaining overflows at Hooffs.

It is recommended the City proceed with the refinement and further development of these projects.

4.2 Complementary Alternative Technologies

It is recommended the City continue to investigate the following as complementary CSO Control Strategies:

- Green Infrastructure;
- Sewer Separation;
- Regulatory Modifications; and
- Real Time Control.

The potential for GI projects are estimated to reduce the total CSO volume by up to 5-10% in a typical rainfall year. The GI alternatives will not achieve the TMDL bacteria reductions on their own; however, GI is an environmental positive and complementary control strategy that can be cost effective when the full benefits of GI are considered. It is recommend the City commit a portion of the overall LTCPU budget to GI. It is further recommended the GI improvements be tied to redevelopment or infrastructure renewal projects whenever practicable, along with City-led projects.

As outlined in the City's Area Reduction Plan (ARP), separation, when tied to redevelopment in the City, can be an effective complementary strategy. Over time, as separation occurs, the bacteria concentration and loads associated with each overflow will decrease. The ARP is a well-established complementary strategy and does not require further development at this time.

Regulator modifications and real time control were both identified as complementary technologies in the *CSO Control Technology Screening Technical Memorandum.* These concepts can be incorporated into the selected primary CSO control strategies as the designs progress.

4.3 Program Enhancements

The *CSO Control Technology Screening Technical Memorandum* also identified a series of program enhancements that are generally good practices, but will likely have little impact on the water quality (bacteria reduction) and CSO control goals, including:

- Catch Basin Modifications (for floatable control);
- Water Conservation;
- Catch Basin Stenciling; and
- Fats, Oils, and Grease (FOG) Program.

These are program enhancements which may or may not be formally incorporated in the final LTPCU.

4.4 Additional Investigation Needs

Based on the recommended short list of primary and complementary control strategies, the follow items are anticipated for further investigation and alternative development:

- Geotechnical and soil permeability study;
- Detailed site selection and alignment study;
- Develop a GI demonstration project; and
- Develop a detailed phasing and implementation plan.

Attachment A

Summary of Alternative Scoring and Ranking

City of Alexandria
LTCPU Alternatives Ranking
CSO 002

Table A1: CSO 002 Alternative Scoring

Date: 5/18/2015

Evaluation Criteria	NPW Cost	Cost	CSO Reduction	Effectiveness	Implementation Effort	Impact to the Community	Expandability	Net Environmental Benefit	Nutrient Credits; Bay TMDL	Permitting Issues	Required Maintenance	Weighted Totals	Ranking
Weighting		40.0%	10.0%	15.0%	5.0%	10.0%	2.5%	5.0%	5.0%	2.5%	5.0%	100%	
T4-A	**$37.2**	4.5	4	5	4	3	4	3	2	1	3	3.97	1
ST002-A	**$32.8**	4.6	4	4	5	3	2	3	2	4	3	3.94	2
D002-A	**$17.3**	5.0	0	5	5	1	1	3	0	2	2	3.43	3
SE002-Royal	**$174.6**	1.0	5	3	2	1	5	2	0	3	5	2.10	5
GI002-Royal	**$63.7**	3.8	2	1	4	5	5	5	2	3	3	3.28	4

City of Alexandria
LTCPU Alternatives Ranking
CSO 003-4

Table A2: CSO 003/4 Alternative Scoring

Date: 5/18/2015

Evaluation Criteria	NPW Cost	Cost	CSO Reduction	Effectiveness	Implementation Effort	Impact to the Community	Expandability	Net Environmental Benefit	Nutrient Credits; Bay TMDL	Permitting Issues	Required Maintenance	Weighted Totals	Ranking
Weighting		40.0%	10.0%	15.0%	5.0%	10.0%	2.5%	5.0%	5.0%	2.5%	5.0%	100%	
T1-A	**$66.8**	4.1	4	4	4	4	4	3	1	3	3	3.78	1
ST003/4-A	**$56.6**	4.7	4	4	1	1	1	3	1	1	3	3.43	2
D003/4-A	**$51.4**	5.0	0	5	2	1	1	3	0	1	2	3.25	3
SE003-King&West	**$123.1**	1.0	5	3	2	1	5	2	0	3	5	2.10	5
GI003/4-King&West	**$75.4**	3.7	2	1	4	5	5	5	1	3	3	3.16	4

City of Alexandria
LTCPU Alternatives Ranking
CSO Control Strategies

Table A3: CSO Control Strategies

Date: 5/18/2015

No.	CSO Control Strategy	Alternatives	NPW Cost	Cost	CSO Reduction	Effectiveness	Implementation Effort	Impact to the Community	Expandability	Net Environmental Benefit	Nutrient Credits; Bay TMDL	Permitting Issues	Required Maintenance	Weighted Totals	Ranking
				40.0%	10.0%	15.0%	5.0%	10.0%	2.5%	5.0%	5.0%	2.5%	5.0%	100%	
S-1	**Storage Tunnels for CSOs 002/3/4**	**T2-A**	**$116.7**	4.2	4	4	4	4	3	3	3	3	3	3.86	3
S-2	**Storage Tunnels for CSOs 002/3/4 and Outfall Relocation to the Potomac**	**T3-A**	**$128.6**	4.0	4	5	4	2	3	3	3	1	3	3.68	6
S-3	**Separate Storage Tunnels for CSO 002 and CSOs 003/4 and Outfall Relocation for CSO 002 to the Potomac**	*T1-A*	*$66.8*		*4*	*4*	*4*	*4*	*4*	*3*	*1*	*3*	*3*		
		T4-A	*$37.2*		*4*	*5*	*4*	*3*	*4*	*3*	*2*	*1*	*3*		
		Total	**$104.0**	4.4	4	4.5	4	3.5	4	3	3	2	3	3.98	1
S-4	**Separate Storage Tanks at CSO 002 and CSO 003/4**	*ST003/4-A*	*$56.6*		*4*	*4*	*1*	*1*	*1*	*3*	*1*	*1*	*3*		
		ST002-A	*$32.8*		*4*	*4*	*5*	*3*	*2*	*3*	*2*	*4*	*3*		
		Total	**$89.4**	4.6	4	4	3	2	1.5	3	3	2.5	3	3.76	4
S-5	**All Disinfection**	*D003/4-A*	*$51.4*		*0*	*5*	*2*	*1*	*1*	*3*	*0*	*1*	*2*		
		D002-A	*$17.3*		*0*	*5*	*5*	*1*	*1*	*3*	*0*	*2*	*2*		
		Total	**$68.7**	5.0	0	5	3.5	1	1	3	0	1.5	2	3.34	7
S-6	**All Separation**	*SE003-King&West*	*$123.1*		*5*	*3*	*2*	*1*	*5*	*2*	*0*	*3*	*5*		
		SE002-Royal	*$174.6*		*5*	*3*	*2*	*1*	*5*	*2*	*0*	*3*	*5*		
		Total	**$297.7**	1.0	5	3	2	1	5	2	0	3	5	2.10	9
S-7	**Storage Tunnel for CSO 003/4 and Tank at CSO 002**	*T1-A*	*$66.8*		*4*	*4*	*4*	*4*	*4*	*3*	*1*	*3*	*3*		
		ST002-A	*$32.8*		*4*	*4*	*5*	*3*	*2*	*3*	*2*	*4*	*3*		
		Total	**$99.6**	4.5	4	4	4.5	3.5	3	3	3	3.5	3	3.97	2
S-8	**Storage Tunnel for CSO 003/4 and Disinfection at CSO 002**	*T1-A*	*$66.8*		*4*	*4*	*4*	*4*	*4*	*3*	*1*	*3*	*3*		
		D002-A	*$17.3*		*0*	*5*	*5*	*1*	*1*	*3*	*0*	*2*	*2*		
		Total	**$84.1**	4.7	2	4.5	4.5	2.5	2.5	3	1	2.5	2.5	3.69	5
S-9	**All Green Infrastructure**	*GI003/4-King&West*	*$75.4*		*2*	*1*	*4*	*5*	*5*	*5*	*1*	*3*	*3*		
		GI002-Royal	*$63.7*		*2*	*1*	*4*	*5*	*5*	*5*	*2*	*3*	*3*		
		Total	**$139.1**	3.8	2	1	4	5	5	5	1.5	3	3	3.23	8

Table A4: Control Strategy Ranking

Date: 5/18/2015

Rank	No.	CSO Control Strategy	Score	
1	S-3	Separate Storage Tunnels for CSO 002 and CSOs 003/4 and Outfall Relocation for CSO 002 to the Potomac	3.98	
2	S-7	Storage Tunnel for CSO 003/4 and Tank at CSO 002	3.97	0.01
3	S-1	Storage Tunnels for CSOs 002/3/4	3.86	0.11
4	S-4	Separate Storage Tanks at CSO 002 and CSO 003/4	3.76	0.11
5	S-8	Storage Tunnel for CSO 003/4 and Disinfection at CSO 002	3.69	0.06
6	S-2	Storage Tunnels for CSOs 002/3/4 and Outfall Relocation to the Potomac	3.68	0.01
7	S-5	All Disinfection	3.34	0.34
8	S-9	All Green Infrastructure	3.23	0.10
9	S-6	All Separation	2.10	1.13

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